PHILOSOPHICAL TRANSACTIONS.

For the Months of *Auguſt* and *September*.

Septemb. 21. 1674.

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Microſcopical Obſervations from Mr. Leeuwenhoeck, *about* Blood, Milk, Bones, *the* Brain, Spitle, Cuticula, Sweat, Fatt, Teares; *communicated in two Letters to the Publiſher. An Account of a notable Caſe of a* Dropſy, *miſtaken for Gravidation in a young Woman; imparted by a Learned Phyſitian in* Holland. *An Account of three Books*: I. *DE SECRETIONE ANIMALI Cogitata, Auth.* Guil. Cole, *M. D.* II. *Eraſmi Bartholini SELECTA GEOMETRICA.* III. *LOGICA, ſive Ars Cogitandi; ex Gallico in Latinum Sermonem verſa. Some Animadverſions upon the* Latin *Verſion, made by* C. S. *of the* Phil. Tranſactions *of A.* 1665. 1666. 1667. 1668:

Microſcopical Obſervations from M. Leeuwenhoeck, *concerning* Blood, Milk, Bones, *the* Brain, Spitle, *and* Cuticula, *&c. communicated by the ſaid Obſerver to the Publiſher in a Letter, dated* June 1. 1674.

Sir,

YOurs of 24th of *April* laſt was very welcome to me; Whence I underſtood with great contentment, that my Microſcopical Communications had not been unacceptable to you and your Philoſophical Friends; which hath encouraged me to proſecute ſuch Obſervations, concerning which I ſhall at preſent impart to you what follows:

1. The ſmall Red Globuls in the Blood, formerly ſpoken of*, are heavier than the Cryſtalline liquor in which they are carried, becauſe ſoon after that the Blood is let out of the Veins, thoſe Globuls by little and little ſubſide towards the bottom; and being made up of ſoft fluid Corpuſcles, and many lying upon one another, they do unite themſelves cloſe together, and by this cloſe conjunction the Blood that is under the ſurface alters its colour, and becomes dark-red or blackiſh; as I have obſerved ſeveral times: of which I take the reaſon to be, (with ſubmiſſion to better Judgments) that the Air cannot move every way round about the Globuls, and hits as 'twere againſt a cloſe darkiſh body. Touching the *Florid* red colour of the ſurface of the Blood expoſed to the Air, that comes, in my opinion, from hence, that the *uppermoſt* Globuls are not preſs'd, and therefore retain their nature, and the Globuls *ſubjacent* to the uppermoſt lye cloſe togerher, by reaſon of which cloſe conjunction the Air or Light cannot penetrate through them, but is reflected, and ſo gives a greater light to, and about, the uppermoſt Globuls, than they had before the union of the inferiour Globuls; and this it is that makes them appear more florid.

*See *Numb.* 102. p. 23.

2. I ſhall herewith communicate the Manner *how* I have obſerv'd, among other things, *Blood* and *Milk*. I did my ſelf prepare divers ſorts of very ſlender hollow Glaſs-pipes, as A B, of which ſome were not thicker than a mans-hair; and the ſlenderer they are, the clearer will they make the red Globuls of the Blood appear. But, for ſeeing the Cryſtalline water in which thoſe Globuls move, and for obſerving alſo how they ſubſide, theſe Pipes may be made ſomewhat thicker. Having then made ready ſuch a ſmall Pipe, I tye about the uppermoſt joynt of (e. g.) my thumb a ſtring, as is uſual in opening a Vein of an Arm, and then I prick that part of my thumb with a pin, to make it bleed; this blood I wipe off, if I intend to keep any for the Air. And then I look well to the place prick't, putting upon that point my Glaſs-pipe, and withal ſqueeſing my thumb to preſs out

See Fig. I.

Fig. 6.

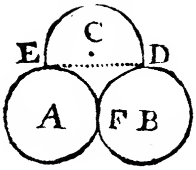


Fig. 5.

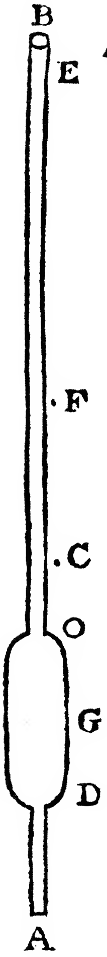


Fig. 4.

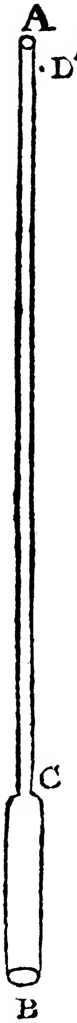
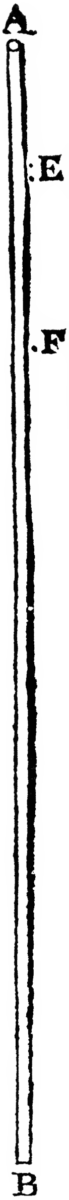


Fig. 1.



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more blood; which being thus preſs'd out, will in part run up into the ſaid pipe: This pipe with the blood in it, I lay upon a piece of white paper, and with my nail break a little piece from it, as *Fig.* 2^{d} or 3^{d}; and ſet it to the pin of my Microſcope, having firſt a little wetted the pin with my ſpittle, or a little turpentine, to make the pipe ſtick to it; or elſe I take the whole Glaſs-pipe, and with my hand hold it before the Microſcope. Now in ſuch a Glaſs-pipe, the blood on the ſurface, and that which is under it, is almoſt of the ſame colour, although it ſtand a pretty while in it, becauſe the Globuls in the Glaſs-pipe are but few, nor lie they ſo cloſe together. The ſlenderer the pipe is, the higher will the blood riſe into it. And that the Curious in your parts might themſelves ſee this, I have uſed the freedom of ſending you ſome of the ſaid hollow Pipes, by the means of which I hope my above-mention'd ſpeculations will be verified.

The red Globuls of the Blood I reckon to be 25000 times ſmaller than a grain of ſand; which perhaps will to many ſeem incredible: But the matter being about figured Bodies, 'tis known, that, two Globes being given, the Axis of one whereof is 1, and that of the other, 20, the proportion between their magnitudes is as 1 to 8000; Spheres being in a triplicat proportion to their Diameters. The ſame red Globuls, when they are ſingle, and ſtick within to the ſides of the Glaſs-pipes, will appear white and colourleſs.

3. Further, if your Curioſity ſhall lead you to obſerve the motion of thoſe red Globuls thorow the Cryſtallin liquor, be pleaſed to take one of the thicker ſort of theſe pipes: filling it with blood from E to F, and ſo putting the lower end B. a little into the flame of a Candle, and cloſing it hermetically. Which done, ſet the pipe upright, with the end A upwards, that ſo the red Globuls may ſink. And deſiring to ſee the motion of thoſe Globuls, apply a little warmth to the pipe between F, B, making uſe only of a warm hand; by which warmth the Air betwixt F, B, muſt expand itſelf into a greater ſpace, and the blood in the pipe will be driven up higher; by which means the red Globuls will in part come to move above in the Cryſtallin humidity; yet if thoſe Globuls come to joyn themſelves too cloſe together, this Obſervation will fail.

See Fig. I.

4. I have ſeveral times endeavoured to obſerve the parts of a *Bone*, and at firſt I imagin'd, I ſaw on the ſurface of the Shinbone of a *Cow* ſeveral ſmall veins (which bone I ſtill keep by me,) but I have not found it ſince in any other bone. I thought likewiſe, I ſaw then alſo, that that Bone conſiſted of united Globuls. Afterwards I viewed the Shinbone of a *Calf*, in which I found ſeveral little holes, paſſing from without inwards; and I then imagined, that this Bone had divers ſmall pipes going longwayes: But I have ſince obſerved the *Tooth* of a Cow and I found it made up of tranſparent Globuls which I can ſee very perfectly. The ſame I have obſerved in *Ivory* or *Elephants-Teeth*. And having ſeen this ſeveral times, I doubt no longer but that all white Bones do conſiſt of tranſparent Globuls. Which being ſo, I am of opinion, that all things that appear white to our eyes are made up of nothing but tranſparent particles lying one upon another: Such as are Snow, white Paper, Linnen, white Stones, white Wood, Scum, beaten Glaſs, beaten Roſin, Sugar, Salt, &c.

5. Again, I have obſerved the *Liver* of a *Sheep*, and that of a fat pletorick *Cow*; and they alſo conſiſted of very ſmall Globuls, which appeared ſo little as thoſe of Blood. The Liver of the Cow was of a Brown-red colour: yet viewing it in my Miſcroſcope, I found the particles, which I took from that Liver, to have but very little colour, only they were a little bright towards the red edge, and generally beſet with very ſmall Globuls of blood; and in ſome few places the blood lay vein-wiſe. Whence I cannot otherwiſe judge, but that theſe ſmall particles of blood lay up and down diſperſed through the Liver out of the veins. I cauſed part of thoſe Livers to be boyled, eſteeming, that by reaſon of their natural ſoftneſs, all could not well be obſerv'd that might be remarkable in it; and I expoſed it to dry ſomewhat hard; and thus in both of them I did ſee the Globuls: which I intend to obſerve yet further

6. The

6. The *Brains* of a Cow being viewed by me, I found the White ſubſtance thereof to be made up alſo of very fine Globuls. As for the Gray colour of the Brain, I have not as yet my ſelf been able to obſerve any thing in it that is particular, by reaſon of its duſkiſhneſs. Now that the Curious may be aſſiſted to view the particles of the brain, I herewith ſend alſo ſome Glaſs-pipes, by me contrived for that purpoſe. A B is a hollow Glaſs-pipe, A C is of the thickneſs of a courſe horſe-hair. Its end from A to D, I thruſt into the white of the Brain (having firſt open'd it with a Pen-knife,) and to the open end B, I apply my mouth, and there ſuck as ſtrongly as I can, and during that ſuction I move the pipe by thruſting it inward and drawing it outward, ſo that the point A remains ſtill moving in the white matter of the Brain: By which means I got a little of that part of the Brain into my Glaſs-pipe, which I view in the manner above-preſcribed in the account of blood. But this I ſhall alſo obſerve again at my next conveniency *.

See Fig. IV.

7. As to the *Marrow* of the Back-bone, I found that alſo to conſiſt of very ſubtil Globuls; yet ſome few Globuls *ſtood out*, of a bigger ſize: Whence I doubted whether theſe bigger Globuls might not be cauſed by the labor of my ſuction and motion, having uſed the ſame way in viewing this Marrow, as I did in obſerving the Brain.

8. Having divers times obſerved the *Fleſh* of a Cow, I found it to conſiſt of very ſlender filaments, lying one by the other as if moven into a film. I have alſo viewed ſeveral filaments, which were beſet with Globuls. Theſe Globuls I judged to be blood, and that, pricking our body with a pin without hitting a vein, the bloody Globuls did iſſue from between theſe filaments: But this I leave to further conſideration. Mean time I have with a pins point ſever'd theſe filaments from one another, and found the ſingle ones ſo fine, that any of them ſeem'd to me ſome 25 times thinner and finer than a hair. Having expoſed them to my Microſcope, I ſaw to my wonder, that they were made up of very ſmall conjoined Globuls, which in ſmalneſs ſeem'd to ſurpaſs all the reſt. This I took

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* *Perhaps it will be ſaid, that the natural texture of the parts of the Brain, by being forced into theſe ſmall pipes, is much altered and vitiated.*

notice of frequently, being unwilling to take up any thing for truth, but what I have ſeen divers times, and in divers parts.

9. Having view'd *faſting Spitle*, I found in that fluid matter carried ſome few and thoſe very ſmall Globuls, of which I obſerv'd ſome to ſubſide. I ſaw alſo therein ſeveral odd particles, ſome of which ſeem'd to conſiſt of united Globuls. But looking upon the *Spitle* in the afternoon, I found thoſe Globuls and odd Corpuſcles in a greater number. I conclude hence, that all Bodies made out of Fluid matter do conſiſt of Globuls; and am therefore of opinion, that if a drop of water could be placed in the free Air, it would be a perfectly round body and conſequently, when out of any fluid matter in our body there are made conſiſtent particles, that they alſo muſt be preſſed together on all ſides: Which preſſure I eſteem to be greater in our Body, than if the Water ſhould preſs the Air, or the Air the Water. And by the ſame preſſure the particles are likewiſe preſſed together; whereupon muſt alſo enſue the roundneſs of their bodies.

10. The *Cuticula* or uppermoſt Skin of our Body conſiſts of round parts or ſmall ſcales, (as far as I have been hitherto able to judge :) And I fancy, that the continual growth of this *Cuticula* is made in this manner: If, *for example*, you let fall upon a white paper a little drop of Gum-water, the water will in a little time ſteam away, and the Gum will keep the ſurface of the drop. Now I imagine this Gum-water to be the humors, that are continually emitted out of our Body, whence the humidity iſſues forth from between all thoſe round particles or ſcales lying cloſe upon another, and not through *pores*, as many have taught. Like a cloſe and well-twiſted Cable, upon which powring continually ſome water, this water will paſs through the whole Cable and ouſe out at the end; not paſſing through any pores, but making its way about and between the filaments of the Cable, and ſo getting out beneath. And the courſer or more conſiſtent matter, which I compare to Gum, cleaves to the body, and ſo maketh the uppermoſt ſkin, which ſkin thus grows on from beneath and is worn off from above: And the more tranſparent theſe particles are, the whiter is our ſkin. Which yet are but our conjectures and ſuſpitions. And the

like

like manner of growing I have formerly ſaid to have place in *Plants*; only with this difference, that, when the ſuperfice of a moiſt Globul, which is given out of the Plant, is become ſomewhat ſtiff, the moiſture is then propelled out of the upper end of the plant, and that by a continual ſucceſſion. Which kind of progreſs of growing I apprehend may in ſome manner be ſeen in the Pith of *Wood*, in *Cork*, in the Pith of *Membranes*, as alſo in the White of a *Quill*; of which three laſt I have ſent you and your curious Friends ſome ſmall particles, cut off with a ſharp Pen-knife, thinking it well worth their obſervation. Only I would here advertiſe, that when any of theſe particles is applied to the pin of ſuch a kind of Microſcope as mine is, the inſtrument may be held within doors and in the ſhade, yet held to the free Air, as if with a Teleſcope you would look upon the Stars in the Firmament.

Other Obſervations made by Mr. Leeuwenhoeck, *about* Sweat, Fatt, Teares; *imparted to the Publiſher in a Letter of* July the *6th* 1674.

1. I Have often viewed the *Sweat* of my face, which conſiſted of a Cryſtallin moiſture, in which I ſaw ſome, but very few, tranſparent Globuls, as alſo a very few, but bigger and odd particles of different forms, which latter I eſteem to be particles ſcaled off from the *Cuticula* or uppermoſt ſkin.

2. I have alſo obſerv'd the *Sweat* of ſeveral Horſes; firſt in ſuch, as ſweat but a little, yet ſo that I could wipe off ſome drops of Sweat from their heads: In which I ſaw likewiſe ſome Globuls ſwimming in the Cryſtallin humidity, as alſo ſome odd bigger parts: But then in Horſes that had labour'd harder, or run more violently, and ſweat ſo as that white ſweat-drops run from their body, I ſaw in them a great abundance of Globuls moving in the Cryſtallin moiſture, together with ſome of thoſe odd bigger parts, which I likewiſe judged to be ſcalings off from the *Cuticular*.

3. Heretofore I acquainted you, that I imagined to have ſeen *Hair* as made up of united Globuls, and to have alſo obſerv'd *Elephant's hair* to conſiſt of the like. I cannot omit

now

now to communicate unto you, that ſince that time I have ſeen ſuch Globuls not only in *Mans* and *Horſe-hair*, but alſo frequently in the *Wool of Sheep*; and further, that the *Root* of the hair pull'd out of my *Eye-brows* conſiſts altogether of the like Globuls.

4. Having pull'd out of an Elephants-tayl a black Hair, and cut tranſverſly from it a thin ſcale, I expoſed it to my Microſcope, which repreſented in the thick of that Hair about an hundred little ſpecks ſomewhat whitiſh, and in each ſpeck a black point, and in ſome few of thoſe black points, a little hole; and this hair conſiſted withal of united Globuls, which yet I thought I ſhould have found bigger in this thick hair of ſo bulky a Beaſt, than indeed they were. This Scale I keep ſtill by me becauſe of its curious and elegant appearance, not unlike (excepting the Colours) a Peacocks-tayl.

5. I have formerly ſent you my way of ſeeing the motion of the Globuls in the Cryſtallin liquor of the *Blood*: Having ſince contrived a more convenient Glaſs-pipe for that purpoſe, I cannot but give you and your Curious Friends notice thereof; *viz.* A B is a hollow Glaſs-pipe from B to O, about the thickneſs of a courſe horſe-hair; from O to D, about the thickneſs of a Pigeons-quil, and the thickneſs from D to A ſomewhat ſlenderer, *ad placitum*. 'Tis open on both its ends, A and B: Into this pipe I brought ſome Blood from E to F, or from E to C, and then ſeal'd the end A hermetically: Or elſe, I leave the pipe cloſed at A, and by the application of my hand or breath bring a little warmth to the thickeſt part of the Glaſs G, holding the pipe with my two fingers at F, and ſo conveying its open end B to the Blood, *&c.* Whereupon ſome of the Air in the pipe, being by the ſaid warmth driven out at the open end B, it will immediately indeavour to have its former ſtate, and ſo attract a little blood into the ſlenderer part of the pipe: which pipe I then put from A to G into a ſmall Copper-pipe, which I had cauſed to be fitted to one of my Microſcopes, and which I can move at pleaſure, nearer or further off, higher or lower.

See Fig. V.

6. I did lately view † ſome Blood, in which there was much of that Cryſtallin liquor, and

† *In one of the newly deſcribed pipes.*

going into the open Air, at a time when there were pretty ſtrong guſts of wind, I ſaw, to my great delight, continually, and without any other motion but that of the wind, the red Globuls agitated peſle-meſle, and as if each Globul had yet a ſecond motion, and that about its axe.

7. I ſhewed to Mr. *C. H.* and couched in writing, how I had obſerv'd the Blood, *&c.* furniſhing him alſo ſome of thoſe ſmall Glaſs-pipes; which together with my Letter being ſent by him to his Son at *Paris*, he had this return from him, that they had ſeen no Globuls at all in the blood, but other particles. This may happen alſo to others, who are therefore hereby advertiſed that thoſe red Globuls, ſtanding ſtill, do ſoon come to ſtick to one another, (as I have obſerv'd my ſelf more than once,) and being thus carried thorow the Cryſtallin humidity, exhibit odd and miſhapen particles: Which doubtleſs is the reaſon, why the ſaid Globuls were not ſeen by the above mention'd perſon, and why indeed they cannot be ſeen in that caſe.

8. Thoſe ſmall Glaſs-pipes, which I am wont to obſerve any fluid matter with, are cloſed by me on both ends; and when I come to make uſe of them, I break off with my nail the cloſed ends, that ſo the Earthy particles, that ſwim continually in the Air, may not get into the pipes, having frequently found, that when thoſe pipes have been open a while in the Air, they are in many places beſet with earthy particles and filaments, which, without this precaution, might be taken for parts of the matter itſelf that is under obſervation.

9. I have heretofore view'd the *Fatt* of Mutton and Cows, and ſhew'd to ſeveral of the Curious, that it is made up of Globuls joyn'd together, which appear'd to my eye, as big as ordinary hail-ſtones: Yet are we not to fancy, as if theſe Globuls, and thoſe that conſtitute a Bone and other ſolid parts, did conſiſt of Globuls *perfectly* round: For, if that were ſo, it muſt follow, that the interſtices betwixt ſuch Globuls would be triangular, or they be fill'd up with other Corpuſcles. But you are to know, that they are round but on one ſide; as, *for example*, A and B are two Globuls of Fat, that are formed firſt, and the third being a forming, and to be placed between and above A and B, it will take the form of C, and ſo

See *Fig*.VI.

ſo make up the triangular body FDE, as in the *Fig.* annext. And thus I think I ſee the groſſer parts of Fat, not perfectly round. And if any of the Curious deſire to ſee the Globuls, of which the greateſt parts of Fat are made up, they may be pleaſed to take care, that there be taken a piece of the courſeſt Fat, and that with the hand it be broken aſunder; which way being obſerv'd, there will then (yet not always) ſome ſmall particles of fat, in the midſt of the fat, be ſever'd, which being dextrouſly applied to the pin of the Microſcope, you will be able to ſee its form: For if you break off a piece of fat with a pin, you will tear the Globuls.

10. I have lately obſerv'd, that each buble or globul of Fat conſiſts of more than a thouſand ſmall Globuls. Yet I am apt to believe, that thoſe that have not ſeen the Globuls in Blood, Hair, Bone, *&c.* will not ſatisfie themſelves about ſeeing the Globuls in the Globuls of Fat, becauſe of their extraordinary minuteneſs.

11. The *Fat* of ſome *Water-foul* and *Fiſh*, though it have been view'd by me, yet ſhall I endeavor to obſerve it again before communication.

12. Having view'd the *Teares* of two infants, I found therein very few round Globuls, but much more other odd and miſhapen particles, of divers forms; ſome of which ſeem'd to conſiſt of united Globuls. I was thinking, becauſe thoſe Tears had run down the Cheeks, whether all theſe particles might not be ſcalings off of the Cuticle. For I preſume, if the Tears of a grown perſon, and ſuch as are cauſed from much grief, and are ſhed copiouſly, were well viewed, there would in all appearance be much more ſeen in them.

An Account of a notable Caſe of a Dropſy miſtaken for Gravidation in a young Woman; communicated by a Learned and Inquiſitive Phyſitian in Holland, *conſiderably enlarging the Obſervation made of the ſame Caſe by the famous Dr.* Tulpius, *lib. 4. Obſ. c.* 48.

SOme years ſince, there came to Dr. *D.* a young Woman of about 17 years of age, unmarried and reputed a Maid, of a florid countenance, and ſtrong body, having a good ſtomach, *periodicè menſtruata*, and wanting none of other due evacuati-